Mesoscale contribution to salinity transport in the North Atlantic subtropics 2011-2013

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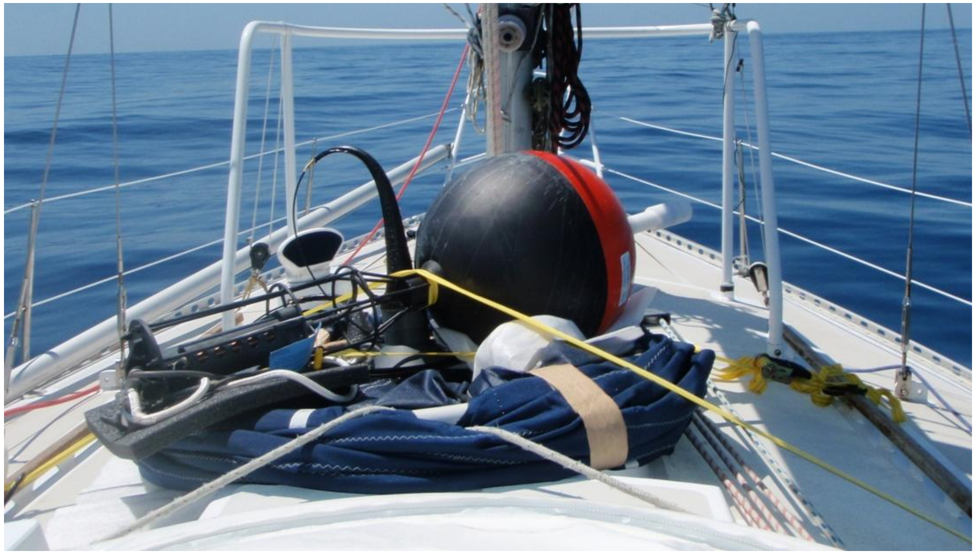
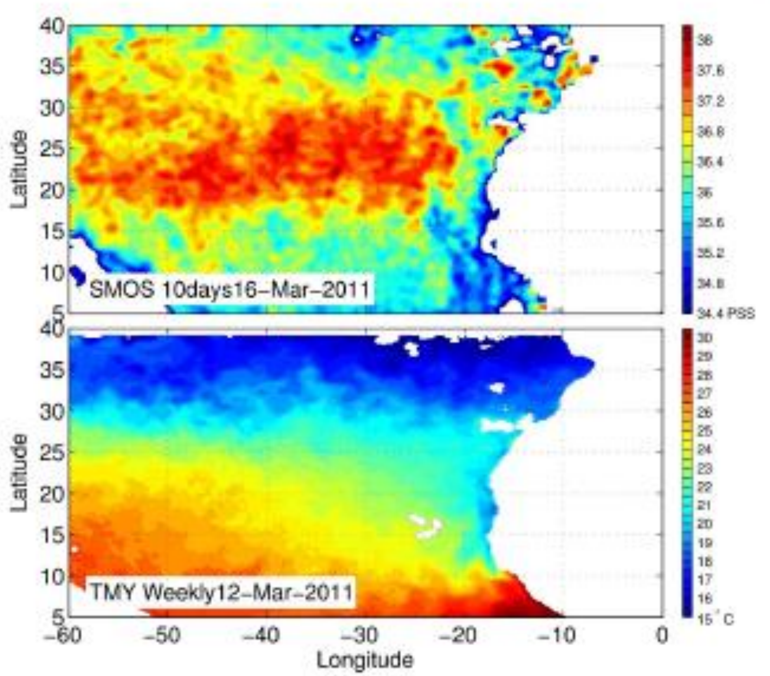
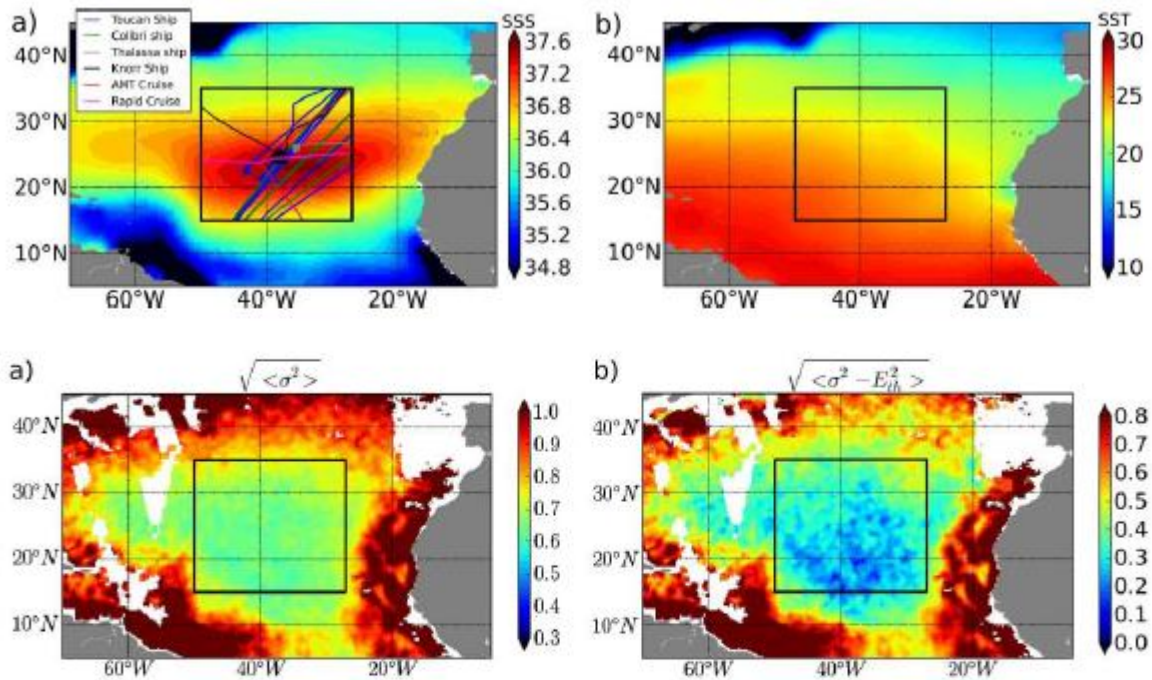
SVP drifters and SMOS/AVISO products to estimate transports





Left: one of the SVP-S drifters measuring SSS and SST (near 50 cm).
Right: example of SMOS 10-day SSS maps (up) and TMI SST (bottom) in May 2011 (from LOCEAN mapped product (Boutin et al., 2013))

SMOS products
variability in SMOS (away from coast + RFI) coherent with signals from TSGs (MN Toucan + Colibri + cruises)



the NASG with different VOS TSG tracks in 2010-2012 used to validate SMOS products (overlapped on SSS from Argo float mapping (ISAS) on the left and SST on the right).

Lower panels: variability in 10-day 100 kmx100km SMOS-derived SSS maps; right panel: residual variability after removal of estimated errors

Comparisons of SMOS with VOS TSGs
Regional seasonal biases in SMOS (or Aquarius) first corrected (from ISAS mapped ARGO data)

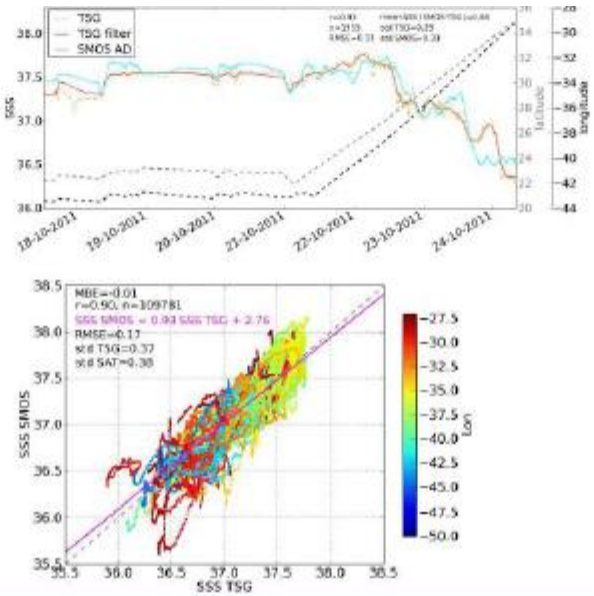
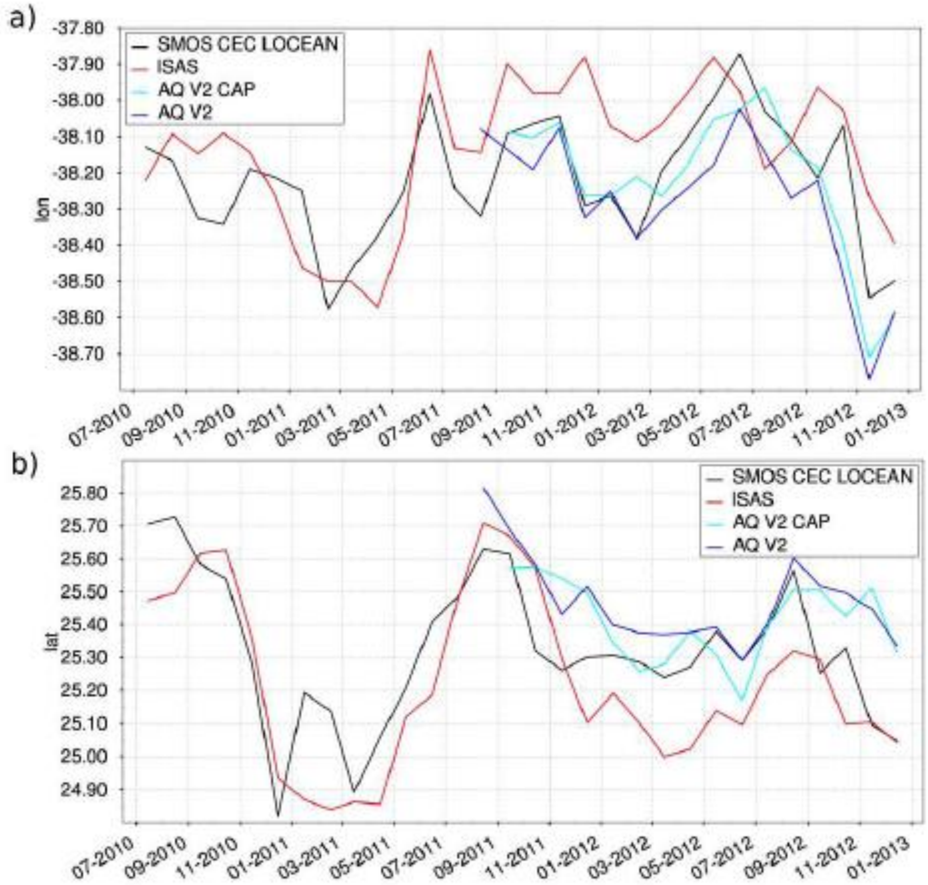


Figure 3 : Comparison of SMOS with TSGs (after correction of average bias based on comparison with Argo floats) (Hernandez et al., 2014)
Upper panel: example of comparison of colocalized SMOS data with TSG data mostly in core of SSS maximum
Lower panel: Scatter diagram of all colocalized SMOS – TSG data (rms 0.17 psu)

Seasonal change in position of large scale SSS maximum according to SMOS/Aquarius/ISAS (but not 2013)



At scales larger than 200 km and a month,
coherence between SSS (SMOS) and SST (TMI)
winter near-density compensation in NE subtropics (seen in TSG)
(Kolodziejzcyk et al., 2014)

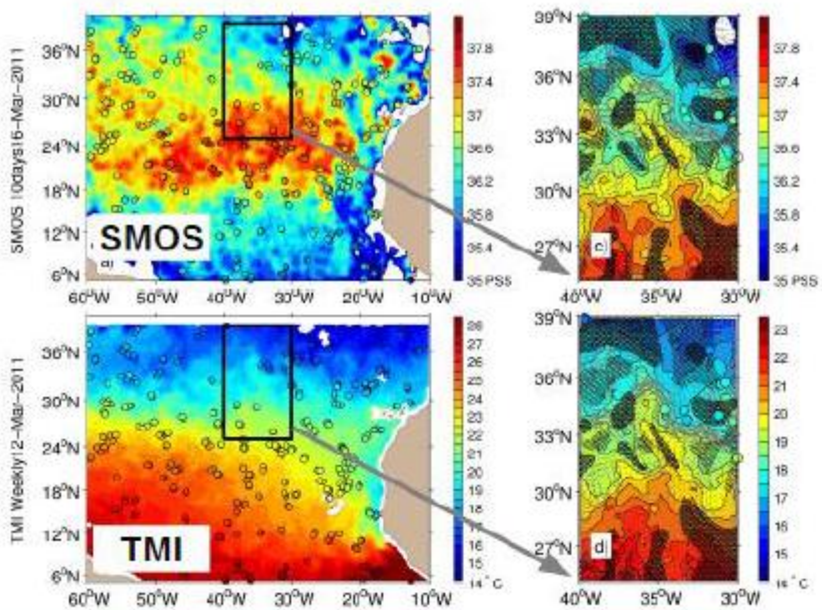


Figure 8 : SMOS SSS and TMI SST filtered data (10 days, 200km) shown in NE NASG region of very similar patterns and near compensation (for density variability) (mid-March 2011)
Left panels: Eastern subtropical NA; right panels: zoom over the box domain. Areas not hatched with near density compensation of T and S contributions.

Transport from V' Aviso and SSS' SMOS

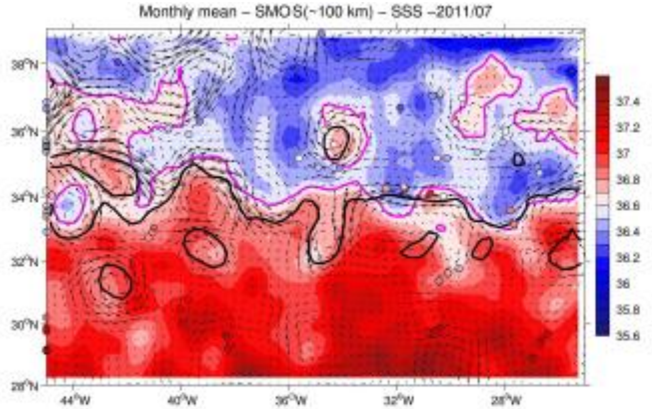
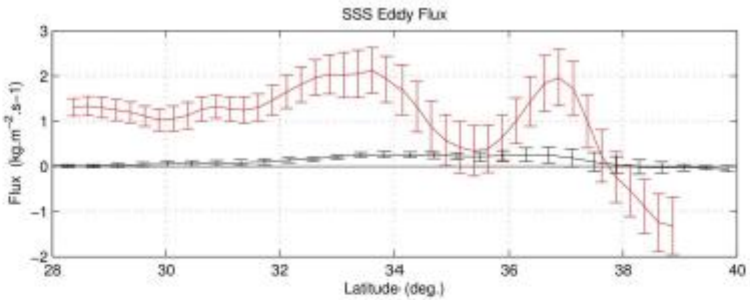


Figure 9 : Upper right, July 2011 monthly average SMOS SSS with currents from AVISO and 8 10^{-5} s^{-1} vorticity isoline (core of Azores Current ; in thick black) and 36.6 isohaline (in thick magenta).



Lower panel: averaged meridional salinity transport (25°W-45°W) from monthly maps of SMOS and AVISO/OSCAR currents (large scale filter 100 km).

For reference, the estimation with the ISAS large analyzed fields is presented.

Drifter velocities/altimetric currents

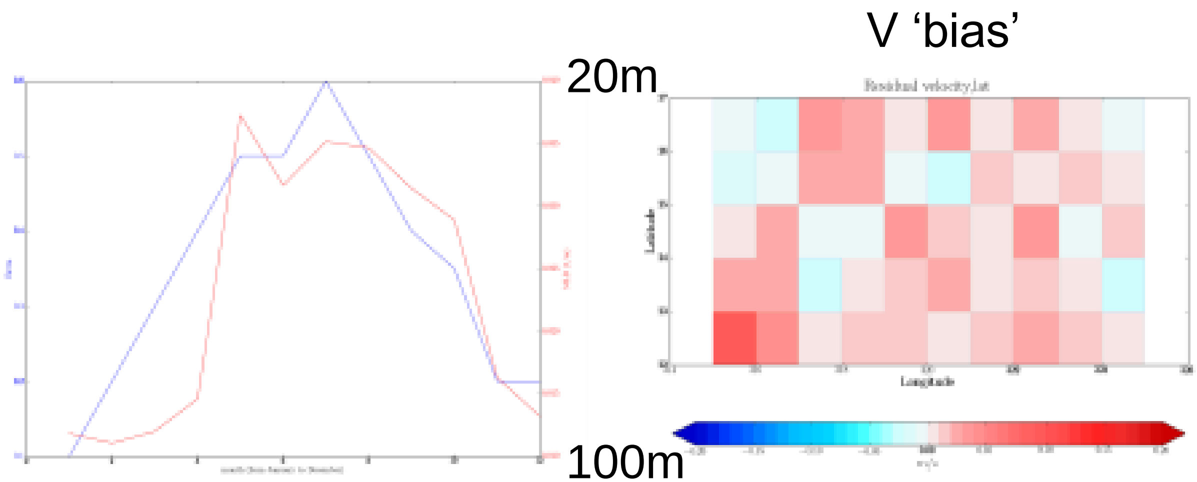


Figure 2 : Buoy drift response to wind fitted to wind stress (τ ECMWF) and after removal of Aviso geostrophic currents $\{\alpha\ \tau\ e(i\Theta)\}$. Left panel coefficient of proportionality α from September 2012 to August 2013. Overlayed is the invers of average monthly mixed layer depth
Right panel: average residual (v) of buoy drifts with wind-response model removed and Aviso currents (possible Aviso mean current error)

SSS variability

The large scales
Rms diff=0.14 cor=0.5

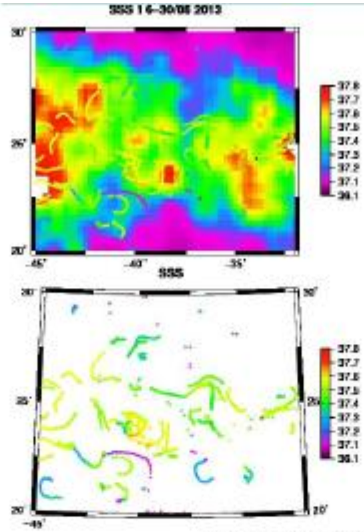


Figure 4 : SPURS, June 16-30 SSS
Upper panel: SMOS map with in situ data overlaid.
Lower panel: The in situ data (Argo and drifters)
Notice the fresh intrusion near 23°N/40°W.

The smaller meso-scales
Can be 0.2 psu

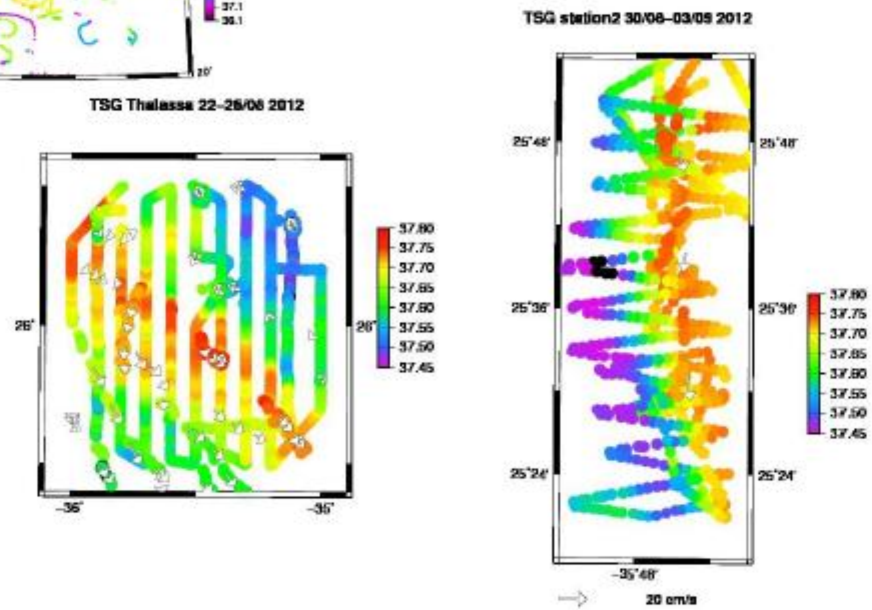


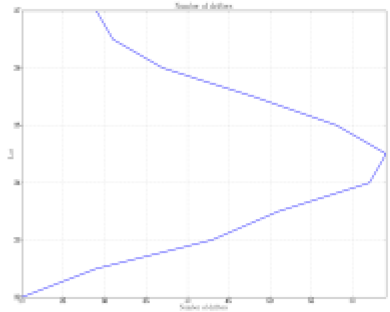
Figure 5 : August 2012 SPURS/STRASSE cruise
Left panel: first Strasse meso-scale survey (22-25/08 2012) with1-day buoy drifts overlaid (largest drifts on the order of 25 cm/s)
Right panel: Following a salty filament over three days. 1-day drifts in the filament are plotted (20 cm/s). Largest southward currents found in the filament

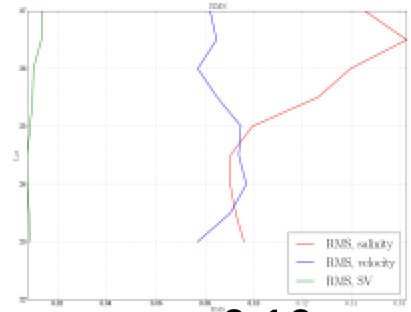
SPURS SSS seasonal signal

top left: number of drifters used (drogued and good SSS)

top right: σ(v), σ(S) at each latitude (seasonal average removed)

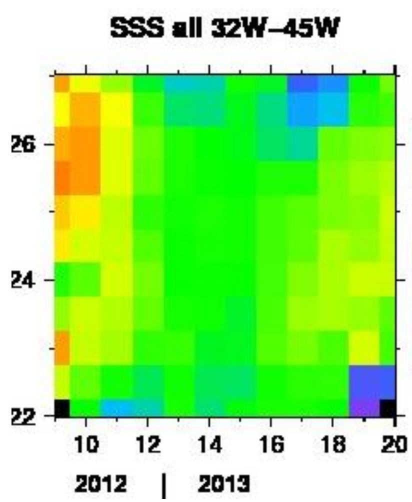
Low left sesonal cycle; right diff in seasonal cycle when only drifter data included)

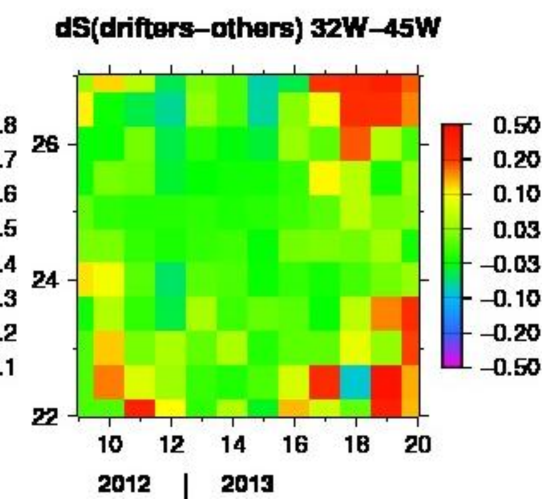




80

0.10





V’S’ (from drifter data)

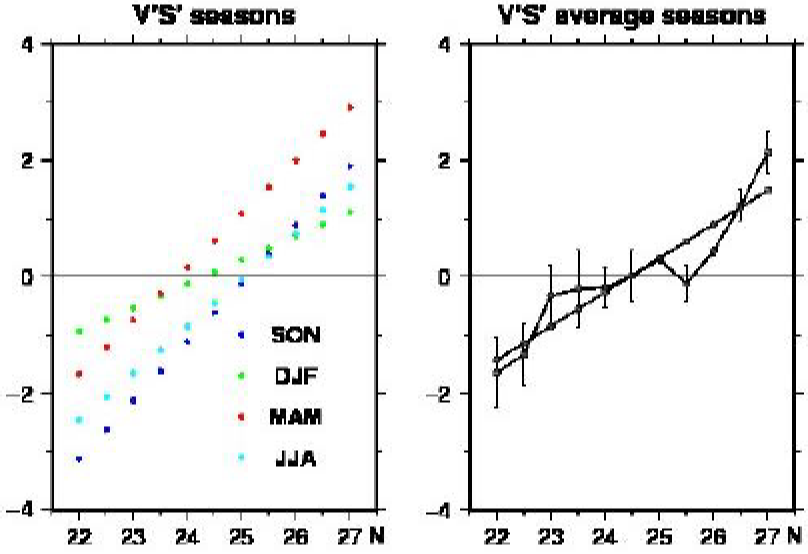


Figure 7 : Estimates of V’S’ (meridional eddy transport) from drifters
Left panel: Linear fits to the seasonal averages (from SON 2012 to JJA 2013) (1 corresponds to 10-3 m/s)
Right panel: Average of the 4 binned seasonal curves (with standard error estimates), and linear fit. With average MLD, this would correspond to equivalent rainfall of 22 cm/year. If seasonal estimates are weighed with seasonal MLD, the average is 30 cm/year.

Perspectives

Good deal of evidence for strong contribution of horizontal eddy transport to SSS budget north of SPURS, but with differences to bridge:

V'S' ~ 1 E-3 from SSS (smoothed 200 km/1 month) + Aviso current

V'S' ~ 3 E-3 from drifter SSS + velocities

Thus 22-30 cm of equivalent rainfall (compared to 130 cm for E-P)

- Could there be biases in drifter data sampling ? (likely, as drifters deployed in region of maximum SSS and very inhomogeneous meridional drifter distribution)

- Is accuracy of SMOS SSS/resolution sufficient? (idem for AQUARIUS)?

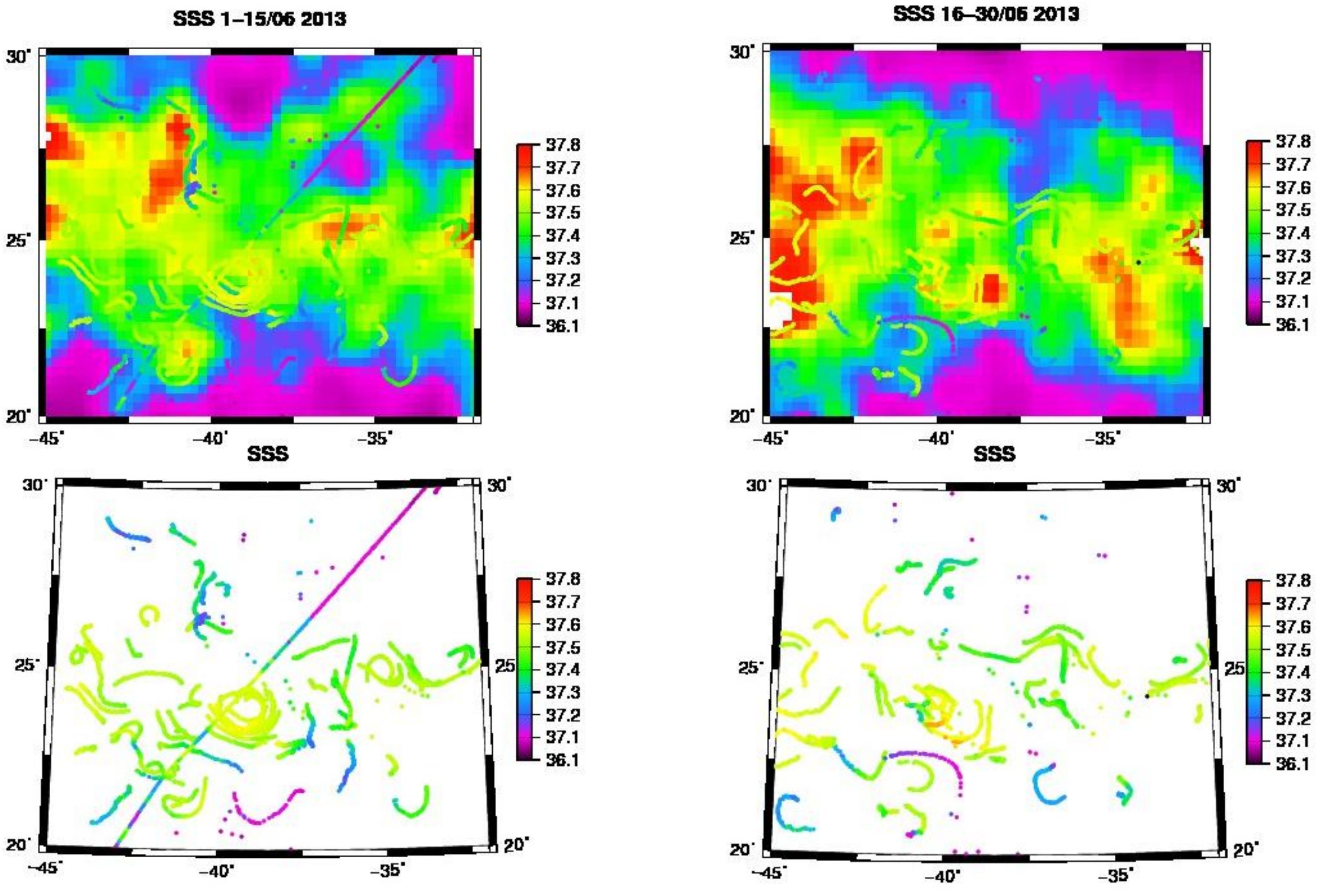
- Is Aviso current accuracy sufficient? (probably not, due to small numberof satellites incorporated (order of 3, but at times, only 2) and suboptimal data filtering/optimal interpolating)

Future: Need to investigate Mercator assimilated simulations;

and check vertical transports...

SPURS S-budget

130 drifters – 30 Argo floats 6 VOS TSGs



rms dif 0.13 cor=04 rms diff 0.14 cor=0.5

TSG (as well as Argo floats) used to validate drifter data